PD CEN/TS 16717:2015

BSI Standards Publication

Surface for sports areas — Method of test for the determination of shock absorption, vertical deformation and energy restitution using the advanced artificial athlete

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National foreword

This Published Document is the UK implementation of CEN/TS 16717:2015.

The document has been produced as a Technical Specification as it describes a new method of measuring the dynamic properties of sports surfaces. Whilst the procedure has been used for several years on long pile synthetic turf sports surfaces, there is little experience of using it on low shock absorbing and deforming surfaces. Additionally, the current calculation of energy restitution and its relevance is currently being further researched.

The UK technical committee advises that users of this Technical Specification should be aware of the following:

- The test results recorded on systems below 25% shock absorption should be used as indicative and not definitive.
- The test results recorded on systems below 4 mm deformation should be used as indicative and not definitive.
- Energy restitution calculation may differ in the future when current research is completed.

The UK participation in its preparation was entrusted to Technical Committee PRI/57, Surfaces for sports areas.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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English Version

Surface for sports areas - Method of test for the determination of shock absorption, vertical deformation and energy restitution using the advanced artificial athlete

Sols sportifs - Méthode d'essai de détermination de l'absorption des chocs, de la déformation verticale et de la restitution d'énergie, au moyen de l'athlète artificiel amélioré

Sportböden - Prüfverfahren zur Bestimmung des Kraftabbaus, der vertikalen Verformung und der Energierückgabe mit dem weiterentwickelten künstlichen Sportler

This Technical Specification (CEN/TS) was approved by CEN on 14 July 2014 for provisional application.

The period of validity of this CEN/TS is limited initially to three years. After two years the members of CEN will be requested to submit their comments, particularly on the question whether the CEN/TS can be converted into a European Standard.

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Foreword

This document (CEN/TS 16717:2015) has been prepared by Technical Committee CEN/TC 217 “Surfaces for sports areas”, the secretariat of which is held by AFNOR.

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1 Scope

This Technical Specification specifies a method of test for measuring the shock absorption, vertical deformation, and energy restitution characteristics of sports surfaces. It is not considered appropriate for rigid sports surfaces that have shock absorbing properties of 10 % FR (Force reduction) or less.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 12229, *Surfaces for sports areas - Procedure for the preparation of synthetic turf and needle-punch test pieces*

EN 12504-2, *Testing concrete in structures - Part 2: Non-destructive testing - Determination of rebound number*

3 Terms, definitions and symbols

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
shock absorption (SA)
ability of a sports surface to reduce the impact force of a body falling onto the surface

Note 1 to entry: This reduction in impact force is expressed as a percentage reduction in force (Force Reduction) when compared to a reference force of 6760 N, which is the theoretical maximum impact force that could occur when the test is undertaken on a rigid non shock absorbing surface (e.g.) concrete.

3.1.2
deformation (D)
measure of how far a test foot compresses or penetrates into the surface when a standard impact force is applied

3.1.3
energy restitution (ER)
measure of the energy returned by the sports surface after the impact force has been applied

3.1.4
energy restitution coefficient
ratio of the dynamic load energy applied to the surface to the energy returned by the surface (R)

3.1.5
sports surface
all components including the playing surface and sub-surface that may influence the dynamic properties of the surface. These may include shockpads or ‘dynamic base constructions for synthetic turf systems, battens and sub-assemblies for indoor flooring structures, etc

3.1.6
point elastic sports surface
sports floor, to which the application of a point force causes deflection only at or close to the point of application of the force

3.1.7
mixed elastic sports surface
point-elastic sports floor with a synthetic area-stiffening component

3.1.8
area elastic sports surface
sports floor, to which the application of a point force causes deflection over a relatively large area around the point of application of the force

3.1.9
combined elastic sports surface
area-elastic sports floor with a point-elastic top layer, to which the application of a point force causes both localized deflection and deflection over a wider area

3.2 Symbols

The following symbols are used in formulas and text throughout this document:

F Force in Newtons;

A Acceleration in ms^{-2};

g Acceleration due to gravity;

SA Shock absorption in %;

D Deformation in mm;

R Coefficient of restitution;

E Energy in Joules;

t time in second

4 Principles

A mass with a spring attached to it is allowed to fall onto the test piece and from the recorded acceleration of the mass from the moment of release until after its impact with the test piece. The following described parameters are calculated.

Shock absorption (SA) is the percentage reduction in the measured maximum force (F_{max}) relative to the reference force (F_{ref}).

Deformation is calculated by double integration of the record of Acceleration vs. time.

Energy restitution coefficient is calculated from the Force vs. Deformation curve.

5 Test specimens

5.1 General

The test specimen shall comprise the entire sports surfacing system.

5.2 Point-elastic and mixed-elastic sports surfaces

For point-elastic and mixed-elastic sports surfaces the test piece shall be a piece of the surface of minimum size 1,0 m by 1,0 m, in combination with the supporting layers to be used in service and using the recommended method of attachment in accordance with the manufacturer's instructions.

5.3 Area-elastic and combined-elastic sports

For area-elastic and combined-elastic sports surfaces, the test piece shall be a sample of the complete surfacing system measuring 3,5 m by 3,5 m, assembled and installed in accordance with the manufacturer's stated method, on a substrate complying with the manufacturer's requirements.

5.4 Synthetic turf and textile sports surfaces

Laboratory test pieces of synthetic turf and textile sports surfaces shall be prepared in accordance with EN 12229.

6 Laboratory tests conditions

6.1 Characteristics of the laboratory floor

The laboratory test floor shall be a concrete floor of minimum thickness 100 mm. The surface hardness when measured in accordance with EN 12504-2 shall be ≥ 40 MPa.

6.2 Conditioning and Test Temperature

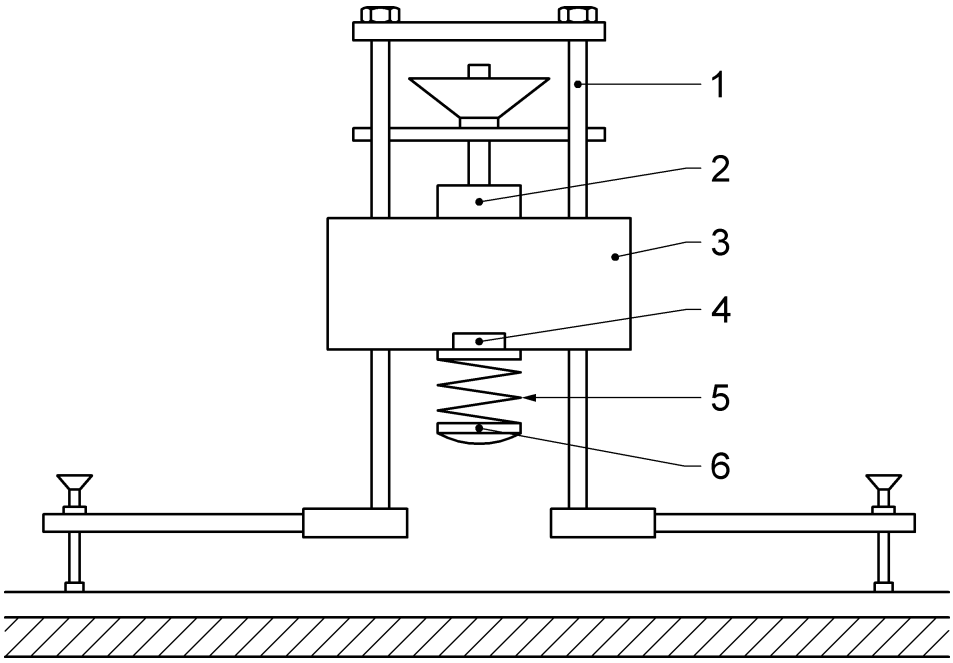
For tests in the laboratory, condition the test piece for a minimum of 24 h at the test temperature. Unless otherwise specified the test temperature shall be 23 °C ± 2 °C.

7 Site tests conditions

Tests on site shall be made at the prevailing ambient temperature and humidity, which shall be recorded and reported.

8 Test Apparatus

8.1 The principle of the test apparatus is shown in Figure 1 and consists of the following essential components specified in 8.2 to 8.9.



Keys

1 guide for the falling mass

2 electric magnet

3 falling mass

4 accelerometer

5 spring

6 test foot

Figure 1 — Test apparatus

8.2 Falling mass (3), incorporating a helical metal spring and steel test foot and fitted with an accelerometer, having a total mass of 20,0 kg ± 0,1 kg.

8.3 Helical steel spring (5), whose characteristic is linear (measured with maximum increments of 1000 N) with a spring rate of 2000 N/mm ± 60 N/mm over the range 0,1 kN to 7,5 kN. The axis of the spring shall be vertical and shall be directly below the centre of gravity of the falling mass. The spring shall have three coaxial coils that shall be rigidly fixed together at their ends. The mass of the spring shall be 0,80 kg ± 0,05 kg.

8.4 Steel test foot (6) having a lower side rounded to a radius of 500 mm ± 50 mm; an edge radius of 1 mm; a diameter 70 mm ± 1 mm and a minimum thickness of 10 mm. The mass of the test foot shall be 400 g ± 50 g.

8.5 Test frame with minimum of three adjustable supporting feet, no less than 250 mm from the point of application of the load for point and mixed elastic surfaces and no less than 600 mm from the point of application of the load for area and combined elastic surfaces. The design of the supporting feet shall ensure the weight of the test apparatus is equally distributed on all the feet.

The pressure (with the mass) on each foot shall be less than 0,020 N/mm^2 and the pressure (without the mass) on each foot shall be greater than 0,003 N/mm^2.

The complete system shall have a mass of ≤ 50 kg.

8.6 A piezo-resistive accelerometer with following characteristics:

— measuring range: ± 50 g;

— 3 dB upper frequency response: ≥ 1 kHz;

— linearity error: < 2 %.

The accelerometer shall be firmly attached to avoid natural filtering and the generation of spurious signals.

8.7 Means of supporting the mass (2) that allows the falling height to be set with an uncertainty of no greater than 0,25 mm.

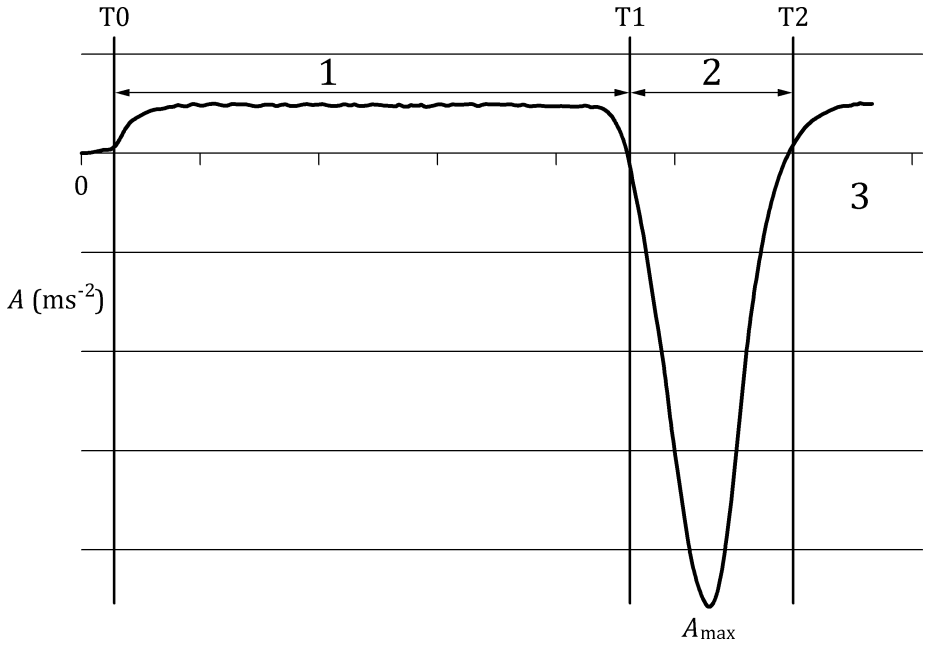
8.8 Means of conditioning and recording the signal from the acceleration sensing device and a means of displaying the recorded signal. (see Figure 2, below):

— sampling rate minimum: 9600 Hz;

— electronic A-to-D converter with a resolution giving 1 bit equal to a maximum 0,005 g acceleration;

— signal from the acceleration-sensing device shall be filtered with a 2nd order low-pass Butterworth filter with a cut-off frequency of 600 Hz.

8.9 Means of calculating the speed and displacement of the falling weight during the course of impact by integration and double integration of the acceleration signal. To be verified in accordance with 9.4 and 9.5.



Key

1 Free drop phase

2 Contact phase

3 Time (s)

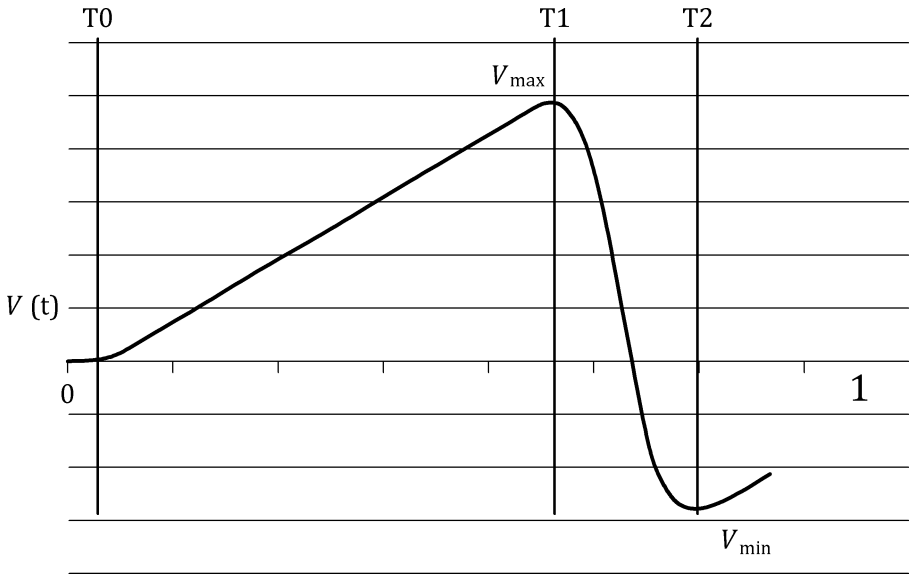
Figure 2 — Example of falling mass acceleration vs .time curve

— T0 time when the mass starts to fall.

— T1 time when the test foot makes contact with the surface (determined on the Velocity / time curve – V_{max} *).

— T2 time (determined on the Velocity / time curve) – V_{min} *) corresponding to the maximum velocity when the mass rebounds after the impact.

NOTE V_{min} and V_{max} can be a minimum or maximum value depending on the sensor's direction.



Key

1 Time (s)

Figure 3 — Example of velocity vs. time curve

9 Verification of impact speed

9.1 General

The verification should be carried out to ensure the correct impact speed (or energy, because the mass is fixed) and the correct functioning of the apparatus.

The checking procedure shall consist of three steps and shall be carried out on a stable and rigid floor (no significant deflection under a 5 kg/cm^2 pressure) as follow:

— laboratory testing: at least once on any day on which testing is undertaken or following dismantling and re-assembly of the test apparatus, prior to carrying out any measurements;

— site testing: following re-assembly of the test apparatus, prior to carrying out any measurements.

9.2 Set up the apparatus to ensure a free drop that is no more than ± 1° from the vertical.

Adjust the height of the lower face of the steel test foot so it is 55,00 mm ± 0,25 mm above the rigid floor.

Drop the weight on the rigid floor and record the acceleration of the falling weight till the end of the impact.

9.3 Repeat 8.1 twice, giving a total of 3 impacts.

9.4 For each impact calculate, by integration from T0 to T1 of the acceleration signal, the initial impact velocity. Calculate the mean impact velocity of the three recordings.

The mean impact velocity shall be in the range of 1,02 m/s to 1,04 m/s.

If the initial impact velocity is outside the specified range the test apparatus is not operating correctly and any subsequent results obtained shall be considered invalid.

9.5 After verifying the initial impact velocity place the falling weight on the rigid floor. Measure the height between a static reference point on the apparatus (for example the magnet) and the falling weight. The measured height shall be used for all measurements and is designated the “lift height”.

NOTE The “lift height” will be slightly greater than 55,0 mm due to the deflection of the apparatus during operation.

10 Checking of force on concrete

At a frequency of at least once every 3 months check the force on the laboratory concrete floor to ensure the consistency of maximum force on concrete as measured by the apparatus and the theoretical force on concrete (6760 N).

The checking shall be carried out in accordance with 9.2 to 9.5 with the addition of F max value (see 11.4).

The mean F max of three consecutive shall be 6760 N ± 250 N.

11 Test procedure

11.1 General

Two test procedures are specified.

Method A shall be used used for surface where the setting of falling height is not possible when the precise distance between the test specimen and the lower face of the steel test foot cannot be measured (e.g. on synthetic or natural turf).

Method B shall be used for surface where it is possible to precisely set the falling height between the surface of sample and the lower face of the steel test foot (e.g. on indoor sport flooring or athletic track surfacing).

To avoid influence of the operator’s weight on the results, through variation in the preload on the sports surfacing system under test, the operator shall be positioned:

— laboratory test off the sample;

— site test (mixed or point-elastic floors) at least 1,0 m from the point of impact;

— site test (area-elastic or combi-elastic floors) at least 2,0 m from the point of impact.

If there is any doubt over the nature of the sports surface under test, the operator shall be positioned at least 2,0 m from the point of impact or off the sample.

11.2 Method A

11.2.1 Set up the apparatus so it is positioned vertically on the test sample.

11.2.2 Lower the test foot smoothly onto the surface of the test piece. Immediately after (within 10 s) set the “lift height” described in 9.5 and re-attach the mass on the magnet.

11.2.3 After 30 (±5) s (to allow the test specimen to relax after removal of the test mass) drop the mass and record the acceleration signal.

11.2.4 Re-validate the lift height after the impact so that within 30 s ± 5 s the mass is lifted from the surface and re-attached to the magnet.

11.2.5 Repeat 11.2.3 - 11.2.4 to obtain a total of 3 impacts.

11.3 Method B

11.3.1 Set up the apparatus so it is positioned vertically on the test sample.

11.3.2 Adjust the height of the lower face of the steel test foot so it is 55,00 mm ± 0,25 mm above the surface of sample.

11.3.3 Drop the mass and record the acceleration signal.

11.3.4 Immediately after (within 10 s) re-attach the mass to the magnet.

11.3.5 After 120 (±5) s (to allow the test specimen to relax after removal of the test mass) repeat 11.3.2 to 11.3.5 two more time to obtain a total of 3 impacts.

NOTE Guidance on the number of test locations for different types of indoor sports flooring is given in Annex A.

11.4 Calculation of Shock Absorption and expression of results

Calculate the maximum force (F_{max}) at the impact with the following formula:

$F_{max} = m \times (A_{max} + g)$

where

F_{max} correspond to the peak force, expressed in Newtons [N];

A_{max} is the peak acceleration during the impact (ms^{-2});

m is the calibrated mass of the falling weight (kg);

g is the acceleration due to gravity (ms^{-2}).

Calculate the Shock Absorption (SA) with the following formula:

$$SA = \left[1 - \frac{F_{max}}{6760}\right] \times 100$$

where

SA is the shock absorption, in %;

F_{max} is the peak force measured on the sport surface (N).

Report the value of Force Reduction in accordance with Table B.1.

11.5 Calculation of Deformation and expression of results

Calculate by a double integration of a(t) on the interval [T1, T2] the displacement of the weight D_{weight} (t), starting at the moment where it has reached its highest velocity (at T1).

The vertical deformation is defined (on the time interval [T1,T2] as:

$VD = D_{weight} - D_{spring}$

where

$$D_{weight} = \max\left[\int_{T1}^{T2}\int_{T0}^{T2} A\ dt\ dt\right], \text{ with } D_{weight} = 0\ \ m\ \ A(t)\ \ T1$$

$$D_{\text{spring}} = \frac{(m \times A_{\max})}{C_{\text{spring}}}$$

where

$F_{\max}$ is the peak force measured on the sport surface (N);

$A_{\max}$ is the peak acceleration during the impact, (9,81 $m.s^{-2}$);

m is the calibrated mass of the falling weight (kg);

C_{spring} is spring constant (Nm^{-1}) (given the certificate of calibration, and measured in the adapted range).

Report the value of Vertical Deformation in accordance with Table B.1.

11.6 Calculation of Energy Restitution and expression of results

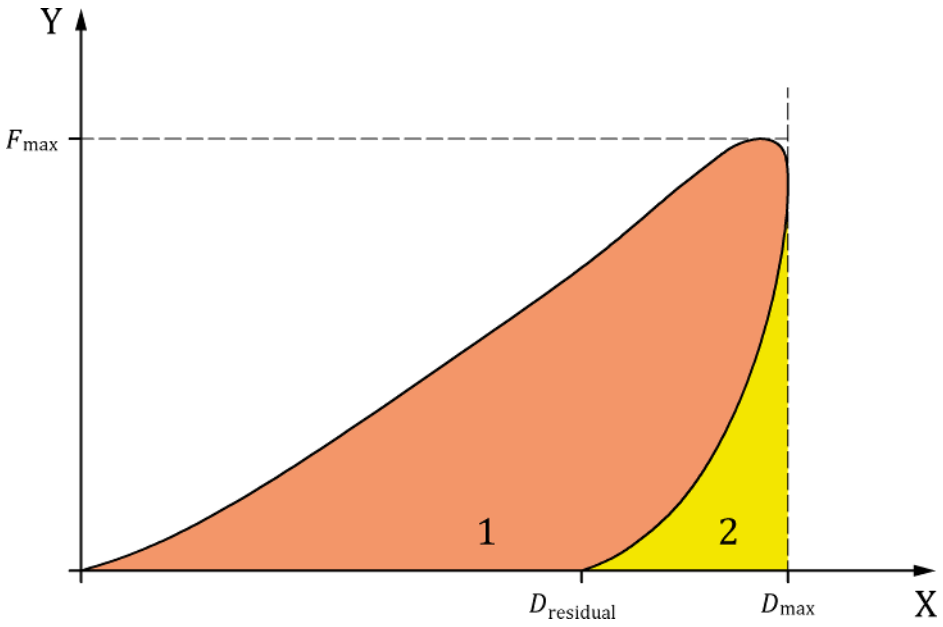
Draw the curves F(t) and D (t) using A(t).

— F(t): Measured force on the surface vs time;

— D (t) Deformation of the surface vs time;

— A(t): acceleration signal from the sensor vs time.

On same time base, draw the curve F(D) (see Figure 4).



Key

1	Energy absorbed
2	Energy restitued
X	Deformation (mm)
Y	Force (N)

Figure 4 — Example of Force vs Deformation curve

Calculate

— The impact energy by the formula:

$$E_i = \int_{D_0}^{D_{max}} F(D)dD$$ initial condition D_0 = 0 m

— The restituted energy with the formula:

$$E_r = \int_{D_{max}}^{D_{residual}} F(D)dD$$

— The coefficient of restitution, R, with the formula:

$$R = \frac{E_r}{E_i}$$

Expression of the results

Report the R value in percentage following Table B.1.

11.7 Checking of the algorithm

When and known signal is entered into the test apparatus software, it shall produce a known result. An example of known signal with associated results is provided in Annex C.

Annex A
(informative)

Positions for laboratory tests on test specimens of indoor area elastic and combined floor

A.1 General

The following figures are provided for guidance on testing positions only. The examples illustrated are not meant to be an exhausted list and this annex is not intended to imply that any system not illustrated cannot be tested or is not considered to be an indoor sports surface.

A.2 Area-elastic sports floor with elastic construction (Figures A.1 to A.5)

NOTE 1 See Figures A.1 to A.5.

NOTE 2 Beam consisting of two parallel one upon another battens, supports staggered.

A.2.1 Key

a upper layer or playing surface (wooden materials with top layer or parquet)

b support layer

c upper battern (beam)

d intermediate support (rigid or elastic, beam)

e bottom battern (beam)

f support structure(rigid or elastic)

⦿ system measuring spot

A.2.2 Positioning of the system measuring spots

System measuring spot 1: Over a support on the beam

System measuring spot 2: Over an intermediate support on the beam

System measuring spot 3: Between system measuring spots 1 and 2 on the beam

System measuring spot 4: At a joint of the beam

— 4a: if the joint is positioned over a support

— 4b: if the joint is positioned over an intermediate support

System measuring spot 5: Between two beams (between a support and an intermediate support) in the area

System measuring spot 6: Between two beams in the area

System measuring spot 7: At a T-joint of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 8: At a joint of the load distribution plate (one measuring direction along the joint, one measuring direction to the area)

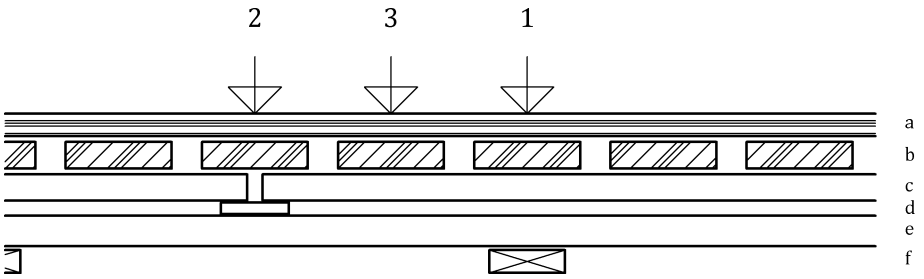


Figure A.1 — Area-elastic sports floor with elastic construction (beam, consisting of two parallel one upon another battens, support staggered)

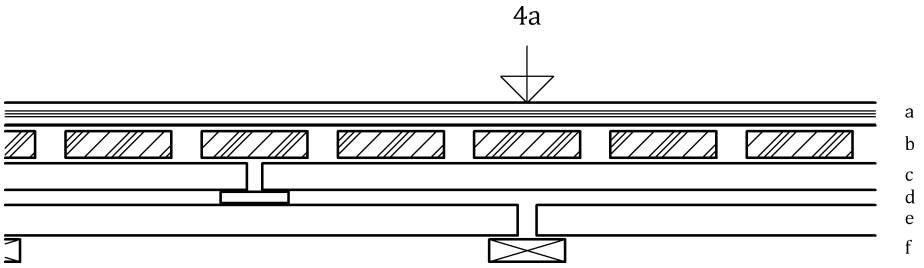


Figure A.2 — Area-elastic sports floor with elastic (beam, consisting of two parallel one upon another battens, support staggered)

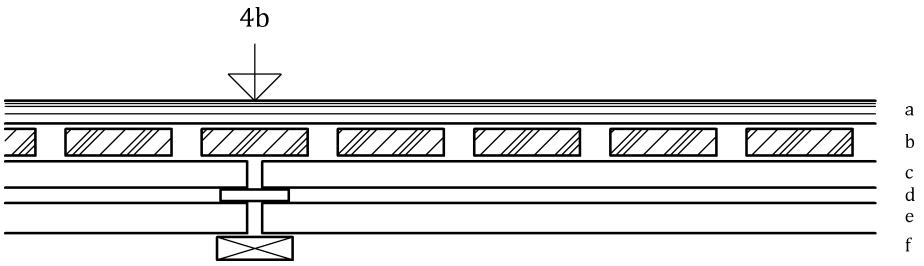


Figure A.3 — Area-elastic sports floor with elastic (beam, consisting of two parallel one upon another battens, support staggered)

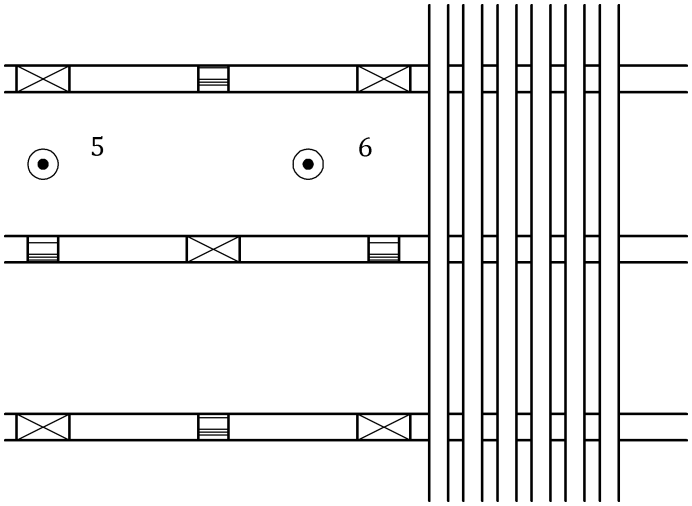


Figure A.4 — Area-elastic sports floor with elastic (beam, consisting of two parallel one upon another battens, support staggered)

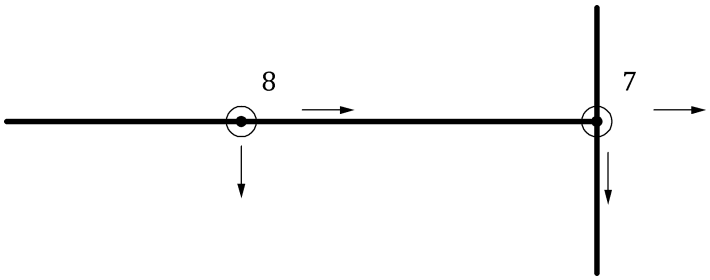


Figure A.5 — Area-elastic sports floor with elastic (beam, consisting of two parallel one upon another battens, support staggered)

A.3 Area-elastic sports floor with elastic construction (Figures A.6 to A.10)

NOTE 1 See Figures A.6 to A.10.

NOTE 2 Beam consisting of two parallel one upon another battens, supports non-staggered.

A.3.1 Key

a upper layer or playing surface (wooden materials with top layer or parquet)

b support layer

c upper battern (beam)

d intermediate support (rigid or elastic, beam)

e bottom battern (beam)

f support structure(rigid or elastic)

⦿ system measuring spot

A.3.2 Positioning of the system measuring spots

System measuring spot 1: Over a support on the beam

System measuring spot 2: Over an intermediate support on the beam

System measuring spot 3: Between system measuring spots 1 and 2 on the beam

System measuring spot 4: At a joint of the beam

— 4a: if the joint is over a support

— 4b: if the joint is over an intermediate support

System measuring spot 5: Between two supports in the area

System measuring spot 6: Between two beams (between intermediate supports) in the area

System measuring spot 7: Between two beams in the area

System measuring spot 8: At a T-joint of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 9: At a joint of the load distribution plate (one measuring direction along the joint, one measuring direction to the area)

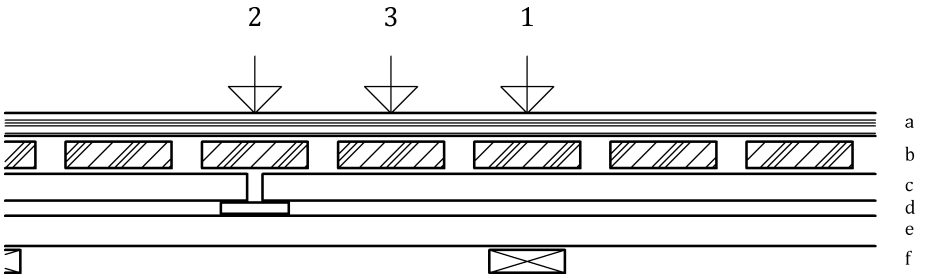


Figure A.6 — Area-elastic sports floor with elastic construction (beam, consisting of two parallel one upon another battens, support non-staggered)

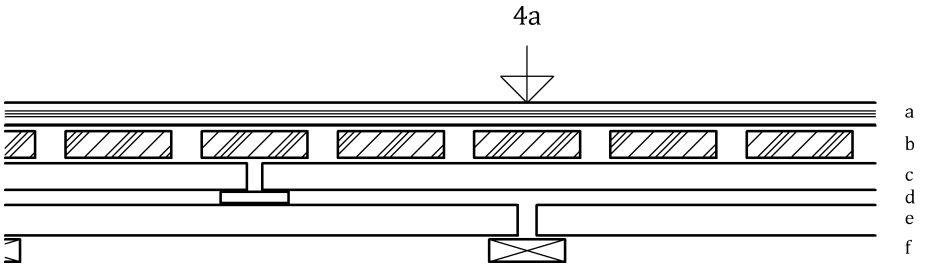


Figure A.7 — Area-elastic sports floor with elastic construction (beam, consisting of two parallel one upon another battens, support non-staggered)

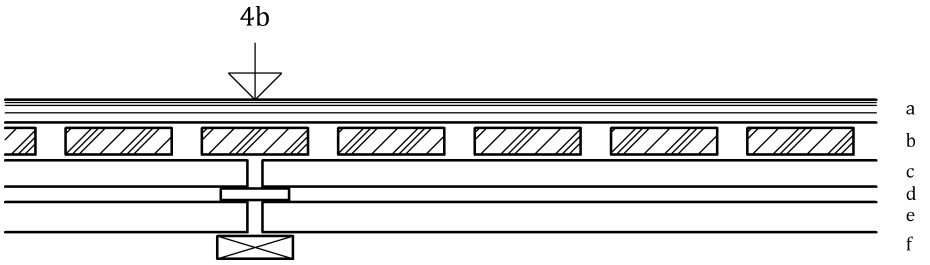


Figure A.8 — Area-elastic sports floor with elastic construction (beam, consisting of two parallel one upon another battens, support non-staggered)

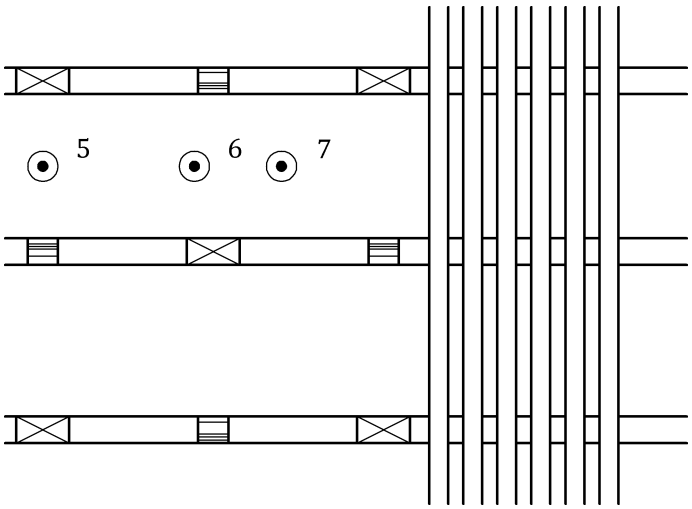


Figure A.9 — Area-elastic sports floor with elastic construction (beam, consisting of two parallel one upon another battens, support non-staggered)

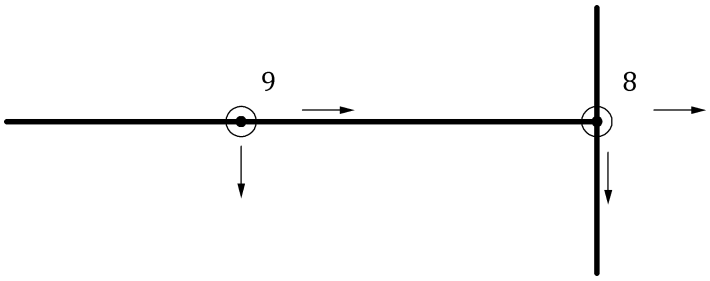


Figure A.10 — Area-elastic sports floor with elastic construction (beam, consisting of two parallel one upon another battens, support non-staggered)

A.4 Area-elastic sports floor with elastic construction (Figures A.11 to A.15)

NOTE 1 See Figures A.11 to A.15.

NOTE 2 With two crosswise batten layers.

A.4.1 Key

a upper layer or playing surface (wooden materials with top layer or parquet)

b support layer

c batten (beam)

d intermediate support (rigid or elastic, beam)

⦿ system measuring spot

A.4.2 Positioning of the system measuring spots

System measuring spot 1: Over a support

System measuring spot 2: Over a cross of the upper/bottom batten layer

System measuring spot 3: Over a joint of the upper batten layer

System measuring spot 4: Over a joint of the bottom batten layer

System measuring spot 5: Between two supports in the area

System measuring spot 6: On the upper batten layer in the area

System measuring spot 7: Between support and upper batten layer

System measuring spot 8: At a T-joint of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 9: At a joint of the load distribution plate (one measuring direction along the joint, one measuring direction to the area)

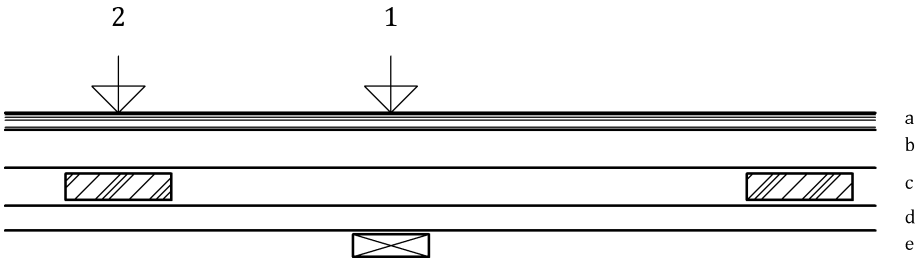


Figure A.11 — Area-elastic sports floor with elastic construction (with two crosswise battens layers)

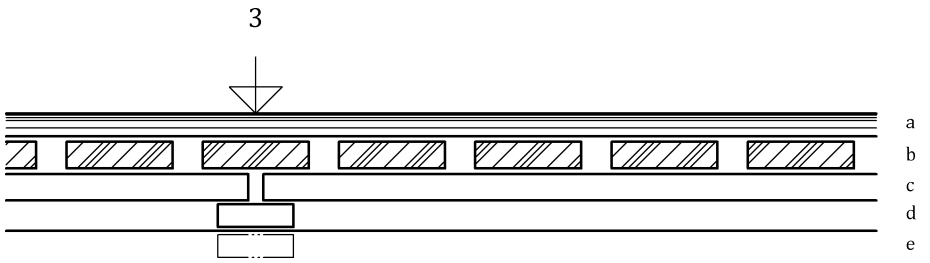


Figure A.12 — Area-elastic sports floor with elastic construction (with two crosswise battens layers)

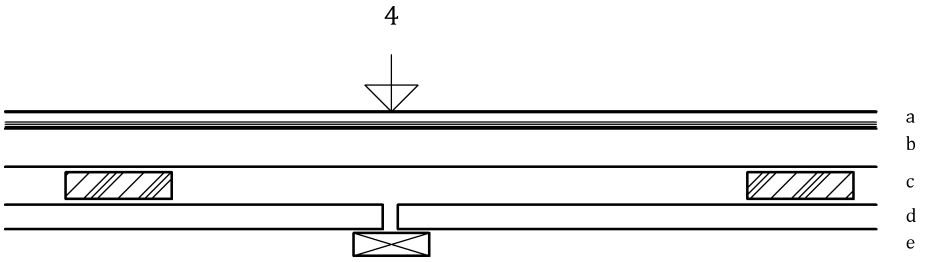


Figure A.13 — Area-elastic sports floor with elastic construction (with two crosswise battens layers)

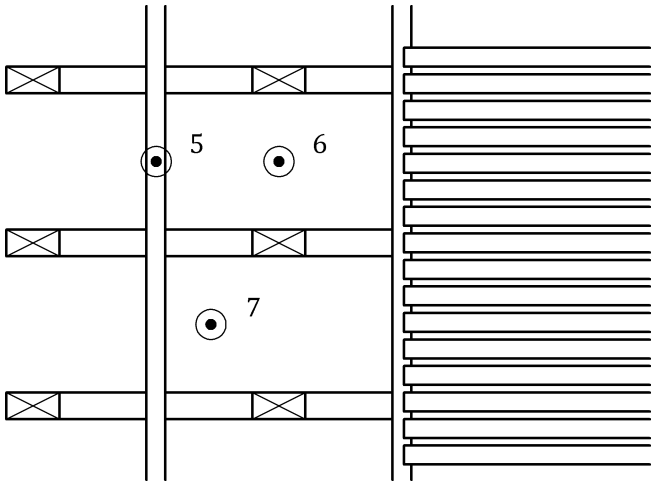


Figure A.14 — Area-elastic sports floor with elastic construction (with two crosswise battens layers)

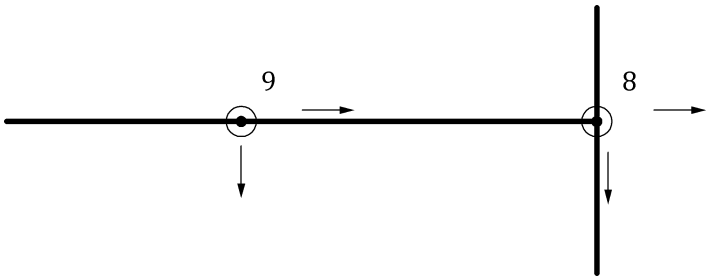


Figure A.15 — Area-elastic sports floor with elastic construction (with two crosswise battens layers)

A.5 Area-elastic sports floor with elastic construction (Figures A.16 to A.19)

NOTE 1 See Figures A.16 to A.19.

NOTE 2 With one batten layer, supports staggered.

A.5.1 Key

a upper layer or playing surface (wooden materials with top layer or parquet)

b support layer

c upper batten (beam)

d intermediate support (rigid or elastic, beam)

e bottom batten (beam)

f support structure(rigid or elastic)

⦿ system measuring spot

A.5.2 Positioning of the system measuring spots

System measuring spot 1: Over a support

System measuring spot 2: Between two supports on the batten

System measuring spot 3: Over a joint of the batten layer

System measuring spot 4: Between two battens in the area (level supports)

System measuring spot 5: Between two battens in the area (level between two staggered supports

System measuring spot 6: At a T-joint of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 7: At a joint of the load distribution plate (one measuring direction along the joint, one measuring direction to the area)

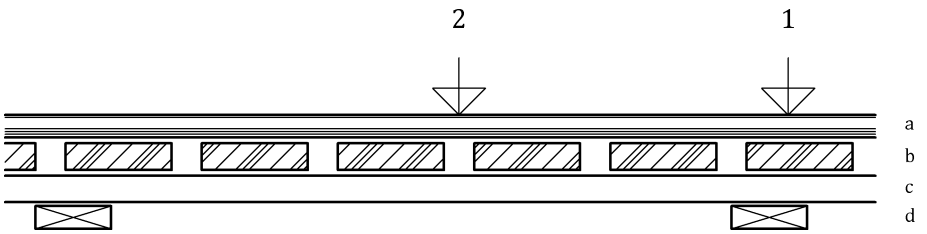


Figure A.16 — Area-elastic sports floor with elastic construction (with one batten layer, support staggered)

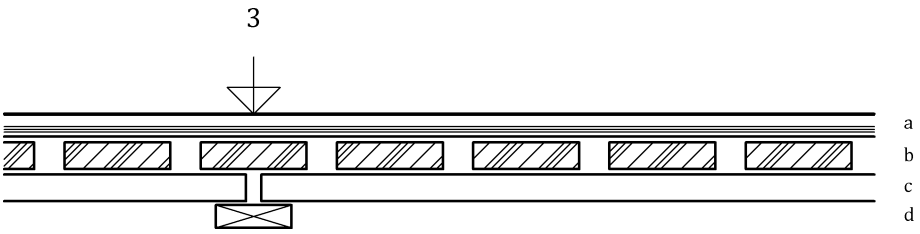


Figure A.17 — Area-elastic sports floor with elastic construction (with one batten layer, support staggered)

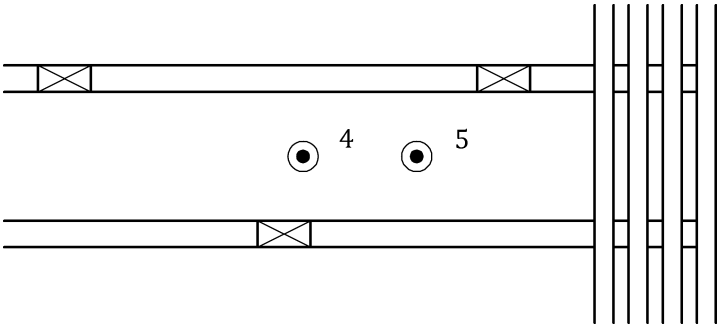


Figure A.18 — Area-elastic sports floor with elastic construction (with one batten layer, support staggered)

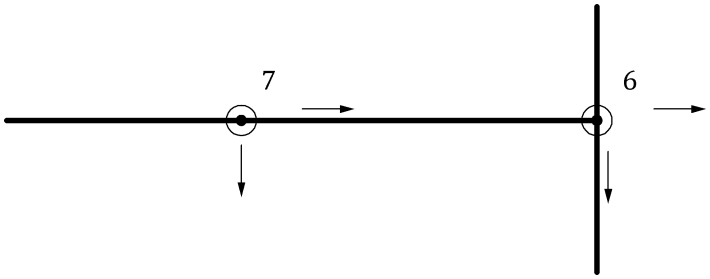


Figure A.19 — Area-elastic sports floor with elastic construction (with one batten layer, support staggered)

A.6 Area-elastic sports floor with elastic construction (Figures A.20 to A.23)

NOTE 1 See Figures A.20 to A.23.

NOTE 2 With one batten layer, supports non-staggered.

A.6.1 Key

a upper layer or playing surface (wooden materials with top layer or parquet)

b support layer

c upper batten (beam)

d intermediate support (rigid or elastic, beam)

e bottom batten (beam)

f support structure (rigid or elastic)

⦿ system measuring spot

A.6.2 Positioning of the system measuring spots

System measuring spot 1: Over a support

System measuring spot 2: Between two supports on the batten

System measuring spot 3: Over a joint of the batten layer

System measuring spot 4: Between two battens in the area (level supports)

System measuring spot 5: Between two battens in the area

System measuring spot 6: At a T-joint of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 7: At a joint of the load distribution plate (one measuring direction along the joint, one measuring direction to the area)

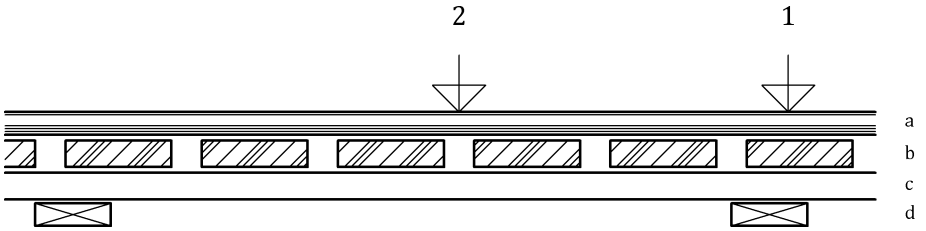


Figure A.20 — Area-elastic sports floor with elastic construction (with one batten layer, support non-staggered)

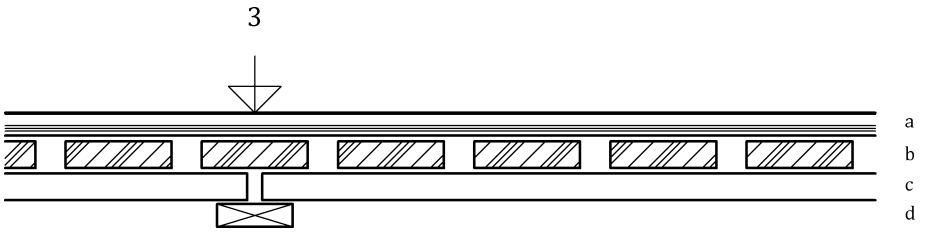


Figure A.21 — Area-elastic sports floor with elastic construction (with one batten layer, support non-staggered)

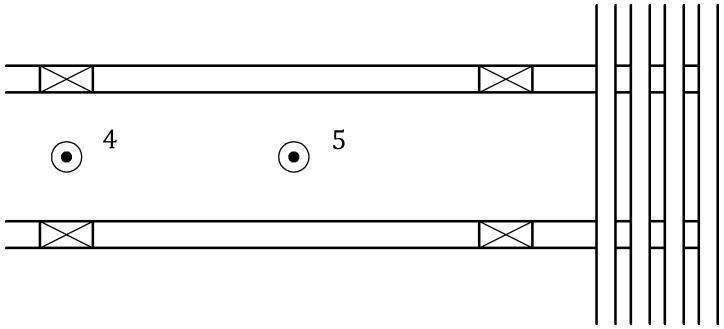


Figure A.22 — Area-elastic sports floor with elastic construction (with one batten layer, support non-staggered)

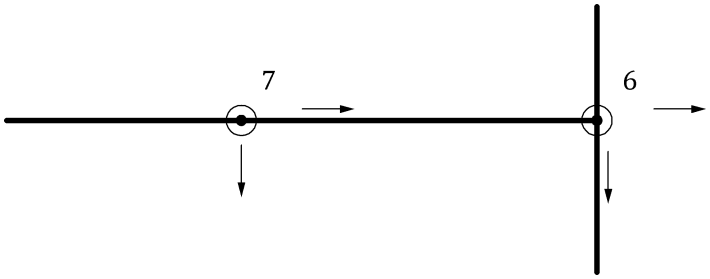


Figure A.23 — Area-elastic sports floor with elastic construction (with one batten layer, support non-staggered)

A.7 Area-elastic sports floor with elastic construction (Figures A.24 to A.25)

NOTE See Figures A.24 to A.25.

A.7.1 Key

a upper layer or playing surface (wooden materials with top layer or parquet)

b support layer

c upper batten (beam)

d intermediate support (rigid or elastic, beam)

e bottom batten (beam)

f support structure(rigid or elastic)

⦿ system measuring spot

A.7.2 Positioning of the system measuring spots

System measuring spot 1: At a T-joint of the upper layer of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 2: At a joint of the upper layer of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 3: At a T-joint of the bottom layer of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 4: At a joint of the bottom layer of the load distribution plate (one measuring direction along a joint, one measuring direction to the area)

System measuring spot 5: At a cross joint (joint of the upper layer of the load distribution plate / joint of the bottom layer of the load distribution plate)

System measuring spot 6: In the area (mid of joints)

If the elastic layer consists of a frame of pads, additional measuring spot have to be placed.

System measuring spot 7: Over a pad

System measuring spot 8: Between the pads

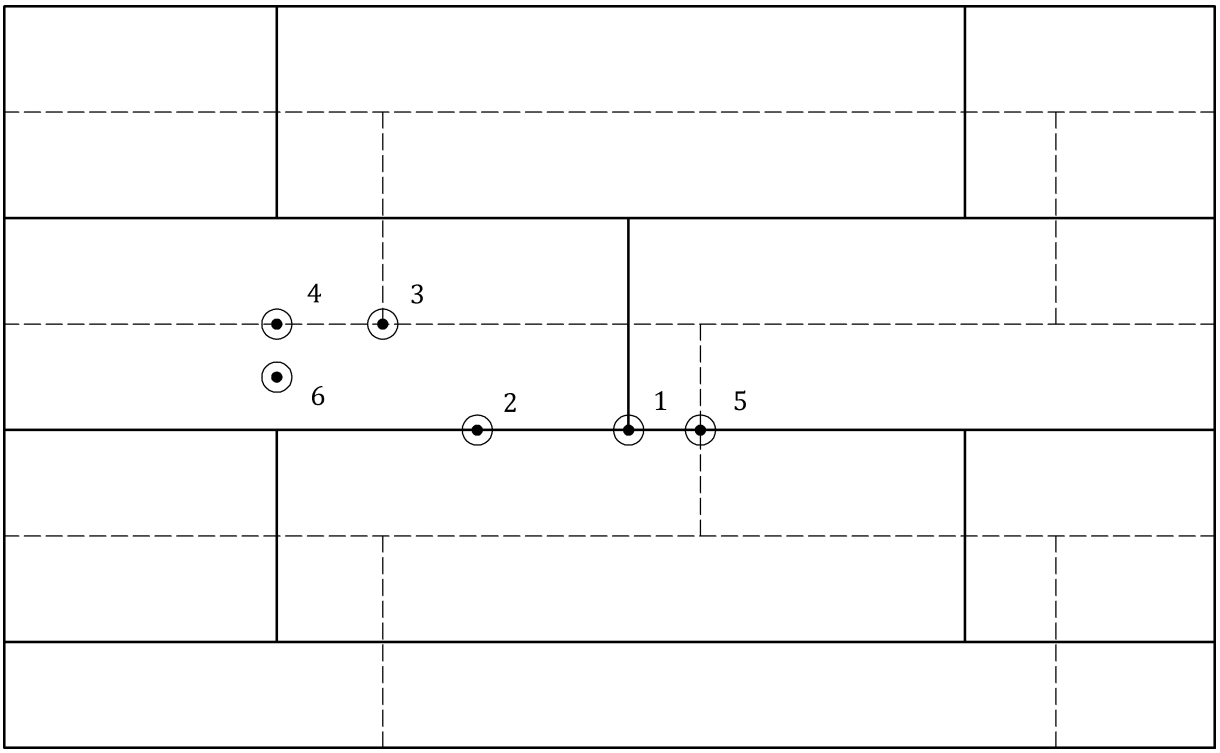


Figure A.24 — Area-elastic sports floor with elastic layer

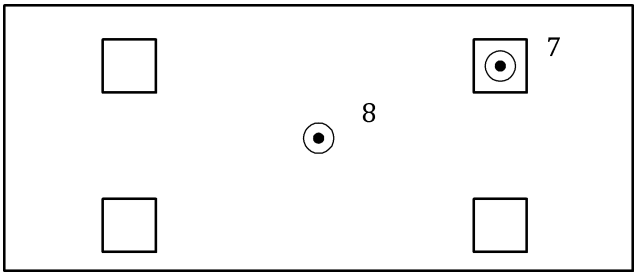


Figure A.25 — Area-elastic sports floor with elastic construction with pads in a frame

A.8 Site test

Test shall be undertaken in the positions specified in the appropriate product standard.

A.9 Positioning of the system measuring spots for indoor point elastic and mixed floors

A.9.1 Laboratory test

Test shall be made in 5 spots on the test specimen, each at least 100 mm apart and at least 100 mm from the sides of the test specimen. When product is manufactured in tiles or panels (surface or sub-surface) with joints between the tiles or panels at least one of the five spots shall be done on a joint.

A.9.2 Site test

Test shall be undertaken in the positions specified in the appropriate product standard.

A.10 Positioning of the system measuring spots for surface for sports areas (EN 14877 and EN 15330)

A.10.1 Laboratory test

Test shall be made in 3 spots on the test specimen, each at least 100 mm apart and at least 100 mm from the sides of the test specimen.

A.10.2 Site test

Test shall be undertaken in the positions specified in the appropriate product standard.

Annex B
(normative)

Expression of results

Results shall be expressed as specified in the relevant product standard or where no requirements are set in in accordance with Table B.1.

Table B.1

	Synthetic and natural turf	Indoor sport flooring	Synthetic surfacing
	Mean of second and third impact in the same location	Mean of the second and third impact in the same location	Mean of second and third impact in the same location
Force reduction (%)	Nearest 1 % e.g. 60 %	Nearest 1 % e.g. 50 %	Nearest 1 % e.g. 40 %
Deformation (mm)	Nearest 0,1 mm e.g. 4,4 mm	Nearest 0,1 mm e.g. 4,4 mm	Nearest 0,1 mm e.g. 4,4 mm
Energy restitution (%)	Nearest 1 % e.g. 34 %	Nearest 1 % e.g. 34 %	Nearest 1 % e.g.34 %

Annex C
(informative)

Example of raw data and theoretical results to check algorithm

Setting:	
Sample rate Hz	20 000
C spring N/mm	2 000
m (kg)	20
F_{ref} (N)	6 760
Filter	Butterworth 600Hz ord2
Theoretric results:	
F_{max} (N)	3 000
F_{red} (%)	55,6 ± 0,1
V_{max} (m/s)	1,043 ± 0,005
V_{min} (m/s)	−0,613 ± 0,005
VD (mm)	6,7 ± 0,1

Samples	G
1	0
to	
747	0
748	0,00004
749	0,00016
750	0,00036
751	0,00063
752	0,00099
753	0,00142
754	0,00193
755	0,00252
756	0,00319
757	0,00394
758	0,00477
759	0,00567
760	0,00666
761	0,00772
762	0,00886
763	0,01007
764	0,01137
765	0,01274
766	0,01418
767	0,01571
768	0,01731
769	0,01899
770	0,02074
771	0,02257
772	0,02447
773	0,02645
774	0,0285
775	0,03063
776	0,03284
777	0,03511
778	0,03746
779	0,03988
780	0,04238
781	0,04495
782	0,04759
783	0,0503
784	0,05308
785	0,05593
786	0,05885
787	0,06185
788	0,06491
789	0,06804
790	0,07124
791	0,0745
792	0,07784
793	0,08124
794	0,0847
795	0,08823
796	0,09183
797	0,09549
798	0,09922
799	0,103
800	0,10686
801	0,11077
802	0,11474
803	0,11878
804	0,12287
805	0,12703
806	0,13124
807	0,13552
808	0,13985
809	0,14423
810	0,14868
811	0,15317
812	0,15773
813	0,16233
814	0,16699
815	0,17171
816	0,17647
817	0,18129
818	0,18615
819	0,19107
820	0,19603
821	0,20105
822	0,20611
823	0,21121
824	0,21637
825	0,22156
826	0,2268
827	0,23209
828	0,23741
829	0,24278
830	0,24819
831	0,25364
832	0,25912
833	0,26465
834	0,27021
835	0,27581
836	0,28144
837	0,28711
838	0,29281
839	0,29855
840	0,30431
841	0,31011
842	0,31594
843	0,32179
844	0,32768
845	0,33359
846	0,33953
847	0,34549
848	0,35148
849	0,35749
850	0,36352
851	0,36958
852	0,37566
853	0,38175
854	0,38786

855	0,394
856	0,40015
857	0,40631
858	0,41249
859	0,41868
860	0,42489
861	0,4311
862	0,43733
863	0,44357
864	0,44982
865	0,45607
866	0,46234
867	0,4686
868	0,47488
869	0,48115
870	0,48743
871	0,49372
872	0,5
873	0,50628
874	0,51257
875	0,51885
876	0,52512
877	0,5314
878	0,53766
879	0,54393
880	0,55018
881	0,55643
882	0,56267
883	0,5689
884	0,57511
885	0,58132
886	0,58751
887	0,59369
888	0,59985
889	0,606
890	0,61214
891	0,61825
892	0,62434
893	0,63042
894	0,63648
895	0,64251
896	0,64852
897	0,65451
898	0,66047
899	0,66641
900	0,67232
901	0,67821
902	0,68406
903	0,68989
904	0,69569
905	0,70145
906	0,70719
907	0,71289
908	0,71856
909	0,72419
910	0,72979
911	0,73535
912	0,74088
913	0,74636
914	0,75181
915	0,75722
916	0,76259
917	0,76791
918	0,7732
919	0,77844
920	0,78363
921	0,78879
922	0,79389
923	0,79895
924	0,80397
925	0,80893
926	0,81385
927	0,81871
928	0,82353
929	0,82829
930	0,83301
931	0,83767
932	0,84227
933	0,84683
934	0,85132
935	0,85577
936	0,86015
937	0,86448
938	0,86876
939	0,87297
940	0,87713
941	0,88122
942	0,88526
943	0,88923
944	0,89314
945	0,897
946	0,90078
947	0,90451
948	0,90817
949	0,91177
950	0,9153
951	0,91876
952	0,92216
953	0,9255
954	0,92876
955	0,93196
956	0,93509
957	0,93815
958	0,94115
959	0,94407
960	0,94692
961	0,9497
962	0,95241

963	0,95505
964	0,95762
965	0,96012
966	0,96254
967	0,96489
968	0,96716
969	0,96937
970	0,9715
971	0,97355
972	0,97553
973	0,97743
974	0,97926
975	0,98101
976	0,98269
977	0,98429
978	0,98582
979	0,98726
980	0,98863
981	0,98993
982	0,99114
983	0,99228
984	0,99334
985	0,99433
986	0,99523
987	0,99606
988	0,99681
989	0,99748
990	0,99807
991	0,99858
992	0,99901
993	0,99937
994	0,99964
995	0,99984
996	0,99996
997	0,96809
998	1
to	

2972	1
2973	0,9994
2974	0,99759
2975	0,99457
2976	0,99034
2977	0,98491
2978	0,97828
2979	0,97044
2980	0,9614
2981	0,95116
2982	0,93971
2983	0,92708
2984	0,91324
2985	0,89821
2986	0,88199
2987	0,86458
2988	0,84599
2989	0,82621
2990	0,80525
2991	0,78312
2992	0,75981
2993	0,73533
2994	0,70969
2995	0,68289
2996	0,65493
2997	0,62581
2998	0,59555
2999	0,56415
3000	0,5316
3001	0,49793
3002	0,46312
3003	0,4272
3004	0,39015
3005	0,352
3006	0,31274
3007	0,27238
3008	0,23093

3009	0,18839
3010	0,14477
3011	0,10009
3012	0,05433
3013	0,00752
3014	−0,04034
3015	−0,08925
3016	−0,13919
3017	−0,19015
3018	−0,24214
3019	−0,29514
3020	−0,34914
3021	−0,40413
3022	−0,46011
3023	−0,51707
3024	−0,575
3025	−0,63388
3026	−0,69371
3027	−0,75449
3028	−0,81619
3029	−0,87881
3030	−0,94235
3031	−1,00678
3032	−1,07211
3033	−1,13831
3034	−1,20538
3035	−1,27332
3036	−1,3421
3037	−1,41172
3038	−1,48217
3039	−1,55343
3040	−1,62549
3041	−1,69835
3042	−1,77199
3043	−1,8464
3044	−1,92156
3045	−1,99747

3046	−2,07412
3047	−2,15149
3048	−2,22957
3049	−2,30834
3050	−2,3878
3051	−2,46793
3052	−2,54872
3053	−2,63016
3054	−2,71224
3055	−2,79493
3056	−2,87823
3057	−2,96213
3058	−3,04661
3059	−3,13165
3060	−3,21725
3061	−3,3034
3062	−3,39007
3063	−3,47725
3064	−3,56494
3065	−3,65311
3066	−3,74175
3067	−3,83085
3068	−3,9204
3069	−4,01038
3070	−4,10077
3071	−4,19156
3072	−4,28274
3073	−4,3743
3074	−4,46621
3075	−4,55847
3076	−4,65106
3077	−4,74396
3078	−4,83716
3079	−4,93065
3080	−5,02441
3081	−5,11843

3082	−5,21268
3083	−5,30716
3084	−5,40186
3085	−5,49675
3086	−5,59182
3087	−5,68705
3088	−5,78244
3089	−5,87797
3090	−5,97361
3091	−6,06937
3092	−6,16521
3093	−6,26113
3094	−6,35711
3095	−6,45313
3096	−6,54919
3097	−6,64526
3098	−6,74133
3099	−6,83739
3100	−6,93341
3101	−7,02939
3102	−7,12531
3103	−7,22115
3104	−7,31691
3105	−7,41255
3106	−7,50808
3107	−7,60347
3108	−7,6987
3109	−7,79377
3110	−7,88866
3111	−7,98336
3112	−8,07784
3113	−8,17209
3114	−8,26611
3115	−8,35987
3116	−8,45336
3117	−8,54656

3118	−8,63946
3119	−8,73205
3120	−8,82431
3121	−8,91622
3122	−9,00778
3123	−9,09896
3124	−9,18975
3125	−9,28014
3126	−9,37012
3127	−9,45967
3128	−9,54877
3129	−9,63741
3130	−9,72558
3131	−9,81327
3132	−9,90045
3133	−9,98712
3134	−10,07327
3135	−10,15887
3136	−10,24391
3137	−10,32839
3138	−10,41229
3139	−10,49559
3140	−10,57828
3141	−10,66036
3142	−10,7418
3143	−10,82259
3144	−10,90272
3145	−10,98218
3146	−11,06095
3147	−11,13903
3148	−11,2164
3149	−11,29305
3150	−11,36896
3151	−11,44412
3152	−11,51853
3153	−11,59217

3154	−11,66503
3155	−11,73709
3156	−11,80835
3157	−11,8788
3158	−11,94842
3159	−12,0172
3160	−12,08514
3161	−12,15221
3162	−12,21841
3163	−12,28374
3164	−12,34817
3165	−12,41171
3166	−12,47433
3167	−12,53603
3168	−12,59681
3169	−12,65664
3170	−12,71552
3171	−12,77345
3172	−12,83041
3173	−12,88639
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